
Space Weather Technical Forecast

Issued on Tuesday, 09 January 2024 at 01:24 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Chance of M-flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Low activity with peak flares C8.7 at 07/2225 UTC from a recently departed region AR3534 on the southwest limb, C7.3 at 08/0959 UTC from AR3539, and a number of other small C-flares from across the disc. There are ten sunspot regions, dominated by two clusters. On the northwest disc, previously active AR3536 remains an elongated spot but now has a simple magnetic structure. AR3538 in the far northwest has shown some complexification, now with a beta-gamma-delta magnetic configuration, yet remains small. Nearby AR3537, AR3542, and AR3539 are all either stable or gradually weakening. AR3943 in the southwest has slowed its growth trend, now with a simpler open structure. The other cluster consists of two sunspots in the southeast, AR3940 and AR3941, both of which are showing some slow growth, but overall also remain relatively simple in terms of their configuration. A single large new region has rotated around the southeastern hemisphere in recent hours, currently appearing as a simple unipolar spot, with a large latitudinal extent. This may be part of a more complex region yet to rotate on, but currently this cannot be deduced with available imagery. No Earth-directed CMEs were observed.

Solar Wind / Geomagnetic Activity: Slow wind conditions persisted, with observed winds by ACE at L1 persisting at background 300-360km/s. Density remained below average. Interplanetary magnetic field (IMF), Bt was weak (0-8nT) with a variable north-south component, Bz, ranging +6 to -6 nT. Phi angle was negative (towards the Sun) until 07/1720 UTC, then positive (away from the Sun). Geomagnetic activity was Quiet.

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux continued to gradually decline towards background, with peak 1.29 pfu at 08/0510. GOES16 high energy (greater than 2MeV) electron flux was at background. The associated 24-hour fluence was below Active throughout. The 09/0000 UTC observation was 2.81e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: There is an ongoing chance of isolated M-flares, with a slight chance of X-class flares.

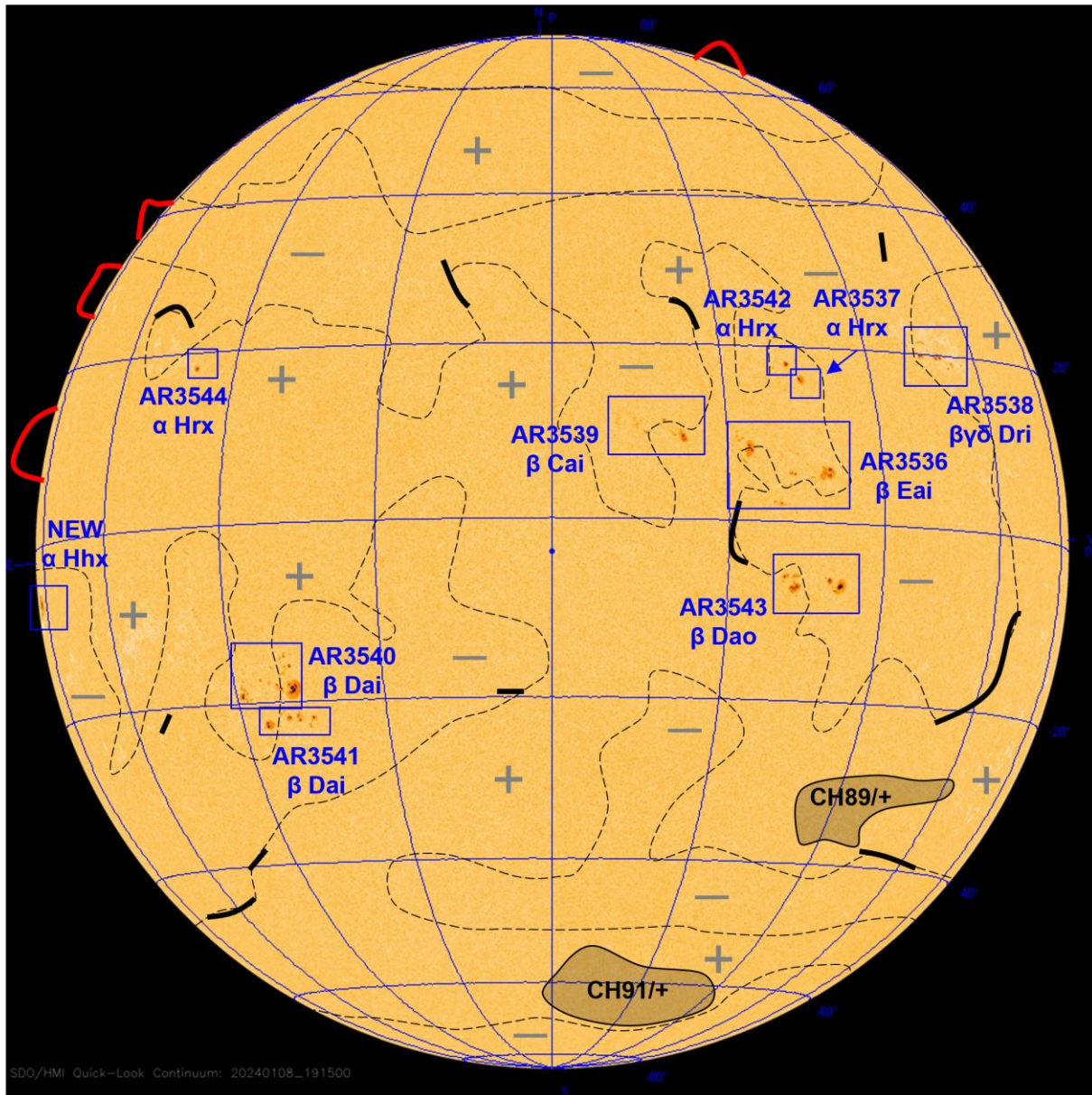
Solar Wind / Geomagnetic Activity: There are two potential glancing CME impacts, one from 05 Jan, arriving day 1 (09 Jan) and another from 06 Jan, arriving later day 1 or day 2 (09-10 Jan), however these are both low confidence. Otherwise some interaction with the fast wind of CH89/+ remains possible day 1 (09 Jan), but this is likely to have only a very limited impact on observed solar winds. Quiet geomagnetic conditions are expected to persist for much of the period, but may rise to Unsettled days 1 and 2 (09-10 Jan), with a chance of Active, in association with any CME or HSS arrival.

Energetic Particles / Solar Radiation: High energy proton flux is forecast to continue declining towards background through the period, but with a slight chance of seeing further increases towards the S1 minor radiation storm threshold given any notable flaring. The high energy electron flux is forecast to remain at mainly background with no notable enhancements

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expected, and the associated 24 hour electron fluence persisting below the Active (1e8) threshold.

Figure 1. Solar Analysis Valid 08/2000 UTC.



Key: Filament ___, Prominence ___, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - γ - $\beta\gamma\delta$ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

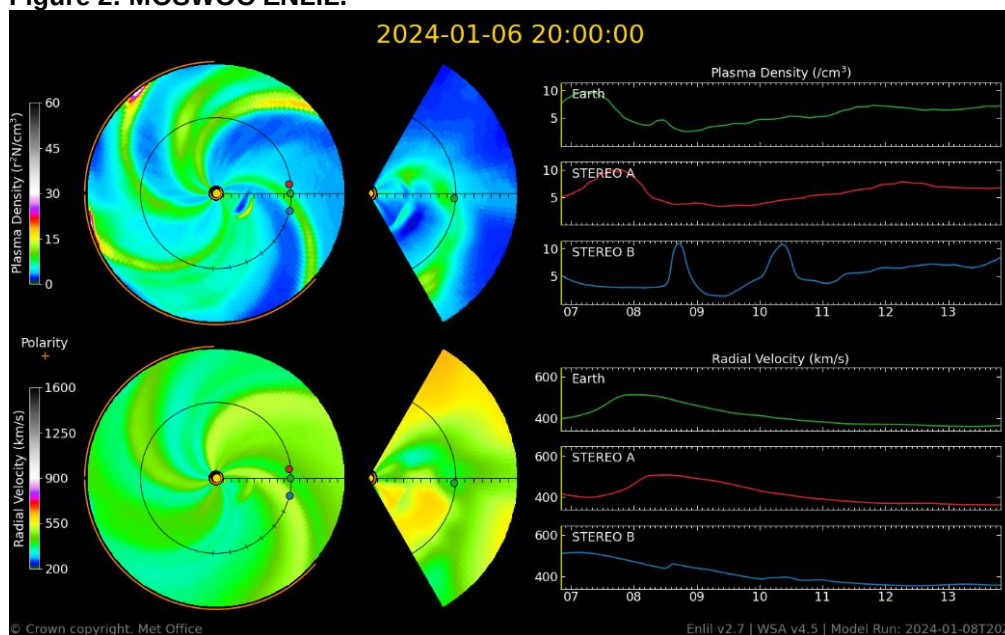
There are two CMEs with potential for Earth-directed components. The first from the northeastern quadrant on 05 January (but directed southeastward) is forecast to perhaps glance the Earth early day 1 (09 Jan). Secondly, a filament eruption CME on 06 Jan been passes close to Earth late day 1 or early day 2 (09-10 January) with the potential for a very slight glancing blow, albeit with very low confidence.

Slow winds have persisted at Earth, contrary to current MOSWOC enlil expectations which would have Earth within a moderate fast wind from CH89/+, of around 550km/s. While some connection to this feature remains possible while it is featured on the southwest limb, it is also possible that Earth remains north of any fast wind that emanates from this coronal hole. Overall, peak winds of around 400-450km/s are possible day 1 (09 Jan) before easing back to background.

Quiet geomagnetic conditions are expected to persist for much of the period, but may rise to Unsettled with a chance of Active, with any fast wind or CME arrival.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	5	5	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: MOSWOC ENLIL.



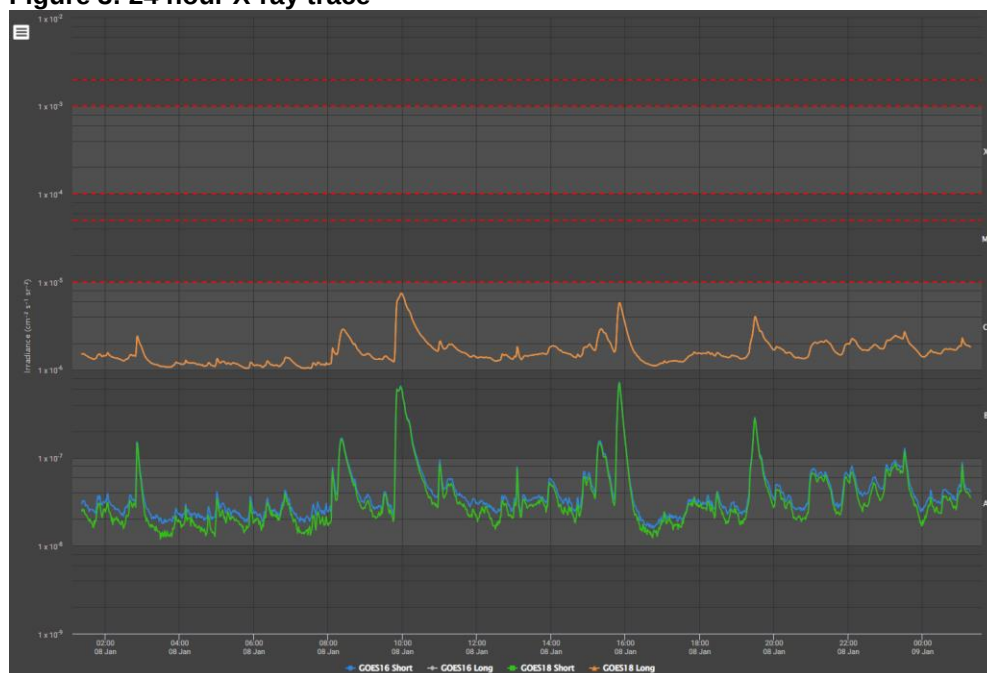
Radio Blackouts - X-Ray Flares:

Low to Moderate activity is expected, with the number of spots on the disc, along with potential regions rotating onto it, leading to a cumulative chance of an isolated M-flare and a slight chance of an X-class flare.

There are ten sunspot regions, dominated by two clusters. On the northwest disc, previously active AR3536 remains an elongated spot but now has a simple magnetic structure. AR3538 in the far northwest has shown some complexification, now with a beta-gamma-delta magnetic configuration, yet remains small. Nearby AR3537, AR3542, and AR3539 are all either stable or gradually weakening. AR3943 in the southwest has slowed its growth trend, now with a simpler open structure. The other cluster consists of two sunspots in the southeast, AR3940 and AR3941, both of which are showing some slow growth, but overall also remain relatively simple in terms of their configuration. A single large new region has rotated around the southeastern hemisphere in recent hours, currently appearing as a simple unipolar spot, with a large latitudinal extent. This may be part of a more complex region yet to rotate on, but currently this cannot be deduced with available imagery.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	55	55	55	55
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3: 24 hour X-ray trace



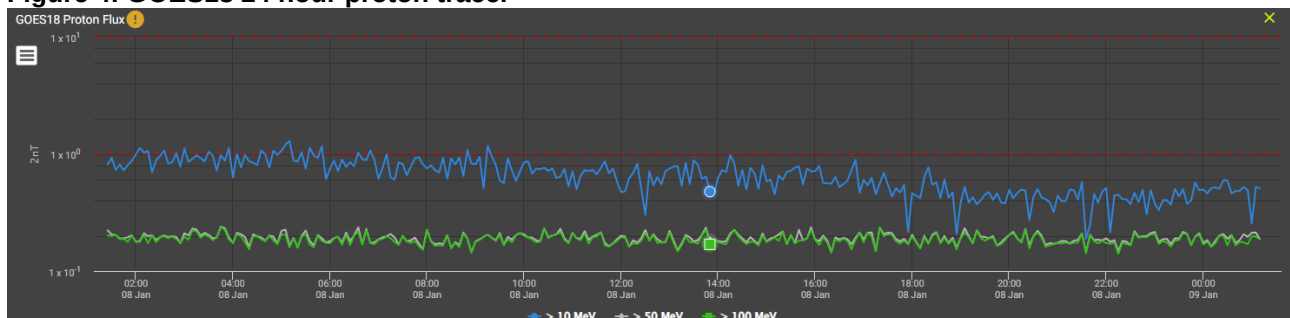
Solar Radiation Storms - (High Energy Protons):

GOES18 high energy (greater than 10MeV) proton flux is currently slightly above background, due to the ongoing effects of the Dec 31 X5.0 flare, and expected to continue to gradually ease. With a number of sunspots on the visible disc, and a large number in the western hemisphere, any further notable flares will also bring a risk of proton flux rising. This will bring a slight chance of reaching the S1 Minor Radiation Storm threshold.

Please note: GOES-18 is currently being used as the primary proton instrument, with GOES-16 data currently unreliable due to a fault reported by NOAA.

Radiation Storms	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	10	10	10	10
Very Active	$\geq \text{S3}$ *	No	1	1	1	1
* S3 $\geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)						

Figure 4: GOES18 24 hour proton trace.



High Energy Electrons Event ($\geq 2\text{MeV}$):

High energy electron flux (greater than 2MeV) as measured by GOES-16 at GEO is currently at background, and in the absence of any significant enhancement is expected to persist at this level. Although brief periods of Moderate flux are possible day 3-4 (10-11 Jan) with in response to any fast wind or CME enhancements that occur.

The associated 24 hour fluence is expected to remain below the Active threshold, with REFM providing good guidance.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	1	1	1	1
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 5: REFM electron fluence forecast/observations/recurrence.

